

Enhanced pion production in DCC dynamics*

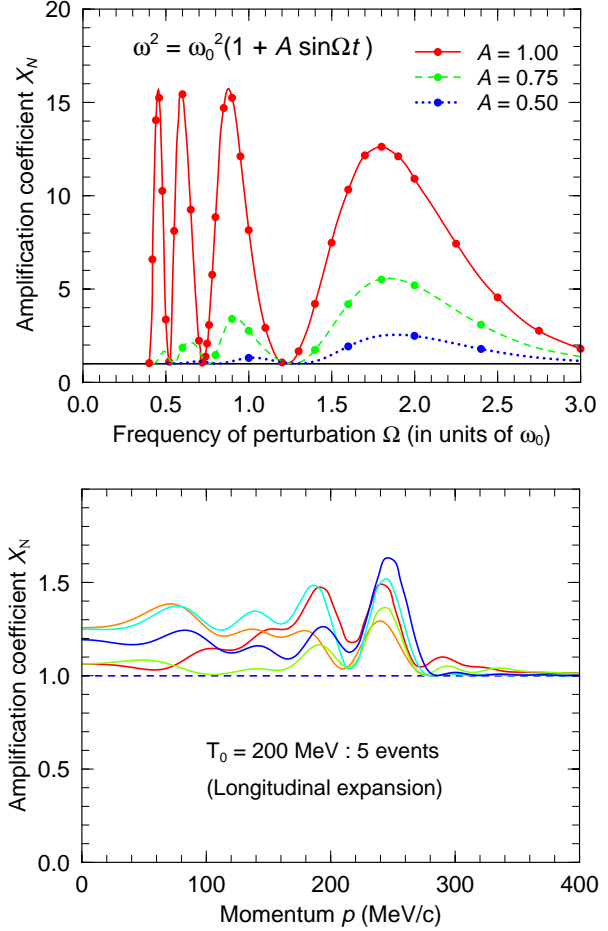
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We have discussed the quantum field treatment of free particles exposed to an arbitrary time-dependent external field that may become supercritical so that spontaneous pair creation occurs. Though of general nature, this problem is particularly relevant to the prospects for forming disoriented chiral condensates in high-energy nuclear collisions, because the key effect is expected to be the amplification of soft pionic modes by either a transient supercritical field or the eventual oscillatory relaxation of the order parameter near its vacuum value.

The quantum treatment brings out the fact that the vacuum and thermal fluctuations contribute in a democratic fashion, both being subject to the same amplification by the factor X_N . The same key result can be obtained entirely within classical mechanics by judicious use of the dependence of the results on the phase of the initial state (top figure).

Employing time-dependent effective masses obtained from dynamical calculations within the linear σ model, we have illustrated the degree of amplification that can occur in possible collision scenarios. A significant enhancement of certain modes is expected to occur as a consequence of the quasi-regular behavior of the chiral condensate, as it relaxes after its initial agitation far away from its vacuum value. A relatively cautious scenario, where neither the initial chiral restoration nor the subsequent expansion is as extreme, yields a modest but persistent enhancement of the soft modes as well as a larger preferential enhancement at a finite pion energy related to the σ mass (bottom figure).

The present formalism makes it possible to calculate the dynamical quantum-field effects on specific pion states, once the time dependence of the effective field is given.



Top: The number enhancement coefficient X_N after the free oscillator has been subjected to two periods of a harmonic perturbation, $\omega^2 = \omega_0^2[1 + A \sin \Omega t]$, as a function of the perturbation frequency Ω in units of ω_0 and using three values of the amplitude A . The curves have been obtained by means of the quantum calculation, X_N^{Qu} , while the solid dots result from the corresponding classical calculation, X_N^{Cl} .

Bottom The final value of the number amplification coefficient X_N as a function of the magnitude of the pion momentum, calculated with the time-dependent mass resulting from subjecting matter in initial thermal equilibrium at $T=200$ MeV to a longitudinal scaling expansion of the Bjorken type (5 events).

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